

# Gauged Linear Sigma Models @30: May 22-26, 2023

Events for:  
Monday, May 22nd - Friday, May 26th

## Monday, May 22nd

9:00am **Workshop: Breakfast - SCGP Cafe**

**Title:** Breakfast

9:30am **Workshop: Eric Sharpe - SCGP 102**

**Speaker:** Eric Sharpe

**Title:** A survey of recent developments in GLSMs

**Abstract:** In this talk, I will give a survey of some developments in gauged linear sigma models over the last fifteen years, focusing on constructions of geometries, quantum cohomology computations and mirror constructions, and analogous results in quantum sheaf cohomology and quantum K theory computations.

10:30am **Workshop: Coffee Break - SCGP Cafe**

**Title:** Coffee Break

11:00am **Workshop: Ilka Brunner (ZOOM) - SCGP 102/ZOOM**

**Speaker:** Ilka Brunner

**Title:** Defects as functors between phases of Abelian gauged linear sigma models

**Abstract:** Defects act naturally on boundary conditions, providing functors between D-brane categories. In the context of gauged linear sigma models, one can use defects to transport branes from one phase to another. In this talk, I will show how to construct such defects explicitly.

12:00pm **Workshop: Lunch - SCGP Cafe**

**Title:** Lunch

1:15pm **Workshop: Peter Koroteev - SCGP102**

**Speaker:** Peter Koroteev

**Title:** Quantum K-theory and Integrability

**Abstract:** I will review the quantum equivariant K-theoretic counts of quasimaps to Nakajima quiver varieties. Then I will explain its connections to the quantum spin chain systems (XXZ) and to the soluble many-body systems (i.e. trigonometric Ruijsenaars). In the end, we will discuss the spaces of q-opers which are in part motivated by the enumerative algebraic geometry, and overview their role in representation theory and integrable models. Based on recent and ongoing work with Anton Zeitlin, Edward Frenkel, and Daniel Sage.

2:15pm **Workshop: Break - SCGP 102**

**Title:** Break

2:30pm **Workshop: Cyril Closset - SCGP 102**

**Speaker:** Cyril Closset

**Title:** Phases of 3d GLSMs to the Grassmannian

**Abstract:** The ordinary 2d GLSM to the complex Grassmannian manifold  $\text{Gr}(N,F)$  is a  $U(N)$  supersymmetric gauge theory with  $F$  fundamental chiral multiplets. We will revisit the 3d  $N=2$  supersymmetric version of this theory. The 3d  $U(N)$  theory is specified by two Chern-Simons levels  $(k, l)$ . We will first discuss the vacuum structure for generic  $(k,l)$ , uncovering a rich pattern of Higgs, topological and hybrid phases. We will then restrict ourselves to values of  $(k,l)$  in which only a pure Higgs phase exists, giving us the Grassmannian  $\text{Gr}(N,F)$ . We will analyse the half-BPS line operators in those theories in some detail. In particular, we will construct new families of line operators that flow to Schubert classes, and we will compute their fusion ring using supersymmetric localisation. In some special case, this reproduces known (physics and maths) results for the quantum K-theory of  $\text{Gr}(N,F)$ . We will also comment on a 3d analogue of the standard 2d LG/CY correspondence as we vary the FI parameter from positive to negative.

3:30pm **Workshop: Tea time - SCGP Cafe**

**Title:** Tea time

4:00pm **Workshop: Sheldon Katz - SCGP 102**

**Speaker:** Sheldon Katz

**Title:** Enumerative geometry of singular Calabi-Yau threefolds associated to hybrid GLSMs

**Abstract:** This talk explores the relationship between certain hybrid GLSMs and the enumerative geometry of singular Calabi-Yau threefolds determined from their superpotentials. To make sense of the enumerative geometry, the singularities of these Calabi-Yaus need to be resolved, either by non-Kähler small resolutions with a nontrivial Brauer class, or by noncommutative resolutions. We claim that the topological string partition function of these small resolutions can be computed from the sphere partition of the GLSMs together with B-model techniques. Performing the geometric calculations on the resolutions, we find complete agreement. The main example will be the singular double cover of  $P^3$  branched along the singular degree 8 hypersurface defined by the vanishing the determinant of a generic  $8 \times 8$  symmetric matrix of linear forms on  $P^3$ . This talk is based on joint work with Eric Sharpe, Thorsten Schimannek, and Albrecht Klemm and joint work in progress with Thorsten Schimannek.

**Tuesday, May 23rd**

9:00am **Workshop: Breakfast - SCGP Cafe**

**Title:** Breakfast

9:30am **Workshop: Sergei Gukov - SCGP 102**

**Speaker:** Sergei Gukov

**Title:** Skyrmions, 2d (0,2) boundaries, and quivers

**Abstract:** In this talk we will explore a class of 3d  $N=2$  theories labeled by graphs and related to quivers in an unusual way. Unlike quiver gauge theories --- a class of Lagrangian field theories widely used in modern QFT --- theories that we consider are non-Lagrangian, in a sense that they can be defined as IR fixed points of gauge fields coupled to non-linear matter as in the Skyrme models of nuclei. Just like the physics of the Skyrme model is intimately tied to symmetries of QCD, generalized symmetries play an important role in these 3d  $N=2$  theories. The connection to quivers, on the other hand, arises in a way that is not standard in modern particle physics, but is standard in the study of logarithmic CFTs and motivic DT invariants.

10:30am **Workshop: Coffee Break - SCGP Cafe**

**Title:** Coffee Break

11:00am **Workshop: Y.-P. Lee - SCGP 102**

**Speaker:** Y.-P. Lee

**Title:** QK = GV for CY3 at  $g=0$

**Abstract:** In this talk, I will show that on a Calabi-Yau threefold (CY3) a genus zero quantum  $\mathbb{Z}$ -invariant (QK) can be written as a linear combination, preserving integrality, of a finite number of Gopakumar--Vafa BPS invariants (GV) with coefficients from an explicit multiple cover formula. Conversely, all Gopakumar--Vafa invariants can be determined by a finite number of quantum  $\mathbb{Z}$ -invariants in a similar manner. The technical heart is a proof of a remarkable conjecture by Hans Jockers and Peter Mayr. This result is consistent with the “virtual Clemens conjecture” for the Calabi–Yau threefolds. A heuristic derivation of the relation between QK and GV via the virtual Clemens conjecture and a “multiple cover formula” will also be explained. This is a joint work with You-Cheng Chou.

12:00pm **Workshop: Group Photo (Lobby) & Lunch - SCGP Cafe**

**Title:** Group Photo & Lunch

1:15pm **Workshop: Hans Jockers - SCGP 102**

**Speaker:** Hans Jockers

**Title:** Non-perturbative Corrections to 3d BPS Indices via Analytic Continuation

**Abstract:** For 3d GLSM parametrized by Kähler deformations, the 3d BPS index defines a  $q$ -series, which can analytically continued in the Kähler modulus by standard techniques. It is argued that the Birkhoff connection matrix governing the analytic continuation captures non-perturbative corrections to the 3d GLSM.

2:15pm **Workshop: Break - SCGP 102**

**Title:** Break

2:30pm **Workshop: Weihong Xu - SCGP 102**

**Speaker:** Weihong Xu

**Title:** A presentation for the quantum K-theory ring of partial flag manifolds

**Abstract:** We give a conjectured generalization of the Whitney presentation for the (equivariant) quantum K-theory ring of Grassmannians by Gu, Mihalcea, Sharpe, and Zou to all partial flag manifolds, and prove it for  $Fl(1, n-1, n)$ . The presentation arises from realizations of partial flag manifolds as GLSMs and highlights the structure of these manifolds as towers of Grassmann bundles. We also verify the specialization of this conjecture in quantum cohomology by comparing it with a presentation given by Gu and Kalashnikov using the abelian/non-abelian correspondence in mathematics. This is joint work with Gu, Mihalcea, Sharpe, Zhang, and Zou.

3:30pm **Workshop: Tea time - SCGP Cafe**

**Title:** Tea time

4:00pm **Workshop: Wei Gu - SCGP 102**

**Speaker:** Wei Gu

**Title:** Heisenberg Spin Chains And Supersymmetric Gauge Theories

**Abstract:** In this talk, we will present how a Heisenberg spin chain emerges from the two-dimensional  $N=(2,2)$  gauge theory at an intermediate scale, which relies on the renormalization group flow guided by the global symmetries and the dynamics of domain walls. Two examples will be discussed: XX-model and its K-theoretic version. Finally, we will briefly comment on the unification of gauge theories from the point of view of the spin chain, and how to approach other formulations of an integrable system via a new point of view.

**Wednesday, May 24th**

9:00am **Workshop: Breakfast - SCGP Cafe**

**Title:** Breakfast

9:30am **Workshop: Huijun Fan (ZOOM) - SCGP 102/ZOOM**

**Speaker:** Huijun Fan

**Title:** LG/CY correspondence between  $tt^*$ -geometries

**Abstract:**  $tt^*$ -geometry structure was found by physicists in the 1980's, and defined and developed later in mathematics at the beginning of 90's. It is an integrable structure mixed with the holomorphic and anti-holomorphic parts, and has close connections with Higgs bundles, Frobenius manifolds and other interesting structures. It is believed that it can be applied to more important occasions. The  $tt^*$  geometrical structures of Calabi-Yau manifolds have been built long ago in the name of "special geometry". In this talk, I will explain my construction of  $tt^*$ -geometry for Landau-Ginzburg model via geometrical analysis method long time ago and formulate very recent results building the explicit LG/CY isomorphism between  $tt^*$  geometrical structures for projective CY hypersurfaces. The latter work appears in arxiv: 2210.16747.

10:30am **Workshop: Coffee Break - SCGP Cafe**

**Title:** Coffee Break

11:00am **Workshop: Kentaro Hori - SCGP 120**

**Speaker:** Kentaro Hori

**Title:** Contour deformation and the grade restriction rule

**Abstract:** The grade restriction rule for B-branes in gauged linear sigma models is determined from the condition of convergence of the integral for the hemisphere partition function. In this talk, I will present the process of determination in the Rodland model (relevant for Pfaffian/Grassmannian correspondence) in which existence of a family of convergent contours is examined. This talk is based on a joint work with Richard Eager, Johanna Knapp and Mauricio Romo.

12:00pm **Workshop: Lunch - SCGP Cafe**

**Title:** Lunch

1:15pm **Workshop: Ed Segal - SCGP 102**

**Speaker:** Ed Segal

**Title:** Fukaya categories at singular values of the moment map

**Abstract:** Given a Hamiltonian torus action on a symplectic manifold, Fukaya and Teleman tell us that we can relate the equivariant Fukaya category to the Fukaya category of a symplectic reduction. Yanki Lekili and I have some conjectures that extend this story - in certain special examples - to singular values of the moment map. I'll also explain the mirror symmetry picture that we use to support our conjectures, and how we interpret our claims in Teleman's framework of 'topological group actions' on categories.

2:15pm **Workshop: Break - Lobby**

**Title:** Break

2:30pm **Workshop: David Favero - SCGP 102**

**Speaker:** David Favero

**Title:** Gauged Linear Sigma Models and Cohomological Field Theories

**Abstract:** This talk is based on joint work with Bumsig Kim, my friend and collaborator. It is dedicated to his memory. Gauged Linear Sigma Models (GLSMs) serve as a means of interpolating between Kahler geometry and singularity theory. In enumerative geometry, they should specialize to both Gromov-Witten and Fan-Jarvis-Ruan-Witten theory. In joint work with Bumsig Kim (see arXiv:2006.12182), we constructed such enumerative invariants for GLSMs. Furthermore, we proved that these invariants form a Cohomological Field Theory. In this lecture, I will describe GLSMs and Cohomological Field Theories, review the history of their development in enumerative geometry, and discuss the construction of these general invariants. Briefly, the invariants are obtained by forming the analogue of a virtual fundamental class which lives in the twisted Hodge complex over a certain "moduli space of maps to the GLSM". This virtual fundamental class roughly comes as the Atiyah class of a "virtual matrix factorization" associated to the GLSM data.

3:30pm **Workshop: Tea time - SCGP Cafe**

**Title:** Tea time

4:00pm **Workshop: Chiu-Chu Melissa Liu - SCGP 102**

**Speaker:** Chiu-Chu Melissa Liu

**Title:** I-functions and central charges of abelian GLSMs

**Abstract:** In this talk, I will introduce several versions of I-functions and central charges of abelian GLSMs. This is based on joint work with Konstantin Aleshkin.

5:30pm **Workshop: Banquet - SCGP Cafe**

**Title:** Banquet

**Thursday, May 25th**

9:00am **Workshop: Breakfast - SCGP Cafe**

**Title:** Breakfast

9:30am **Workshop: Sebastian Franco - SCGP 102**

**Speaker:** Sebastian Franco

**Title:** 2d (0,2) Gauge Theories from Branes: Recent Progress in Brane Brick Models

**Abstract:** We will discuss the realization of 2d (0,2) gauge theories in terms of branes focusing on Brane Brick Models, which are T-dual to D1-branes probing toric Calabi-Yau 4-folds. These brane setups fully encode the infinite class of 2d (0,2) quiver gauge theories on the worldvolume of the D1-branes and substantially streamline their connection to the probed geometries. They also provide a brane realization of Gaiotto-Gukov-Putrov triality. We will discuss various methods for efficiently generating Brane Brick Models. These algorithms are in turn used to construct 2d (0,2) gauge theories for the cones over all the smooth Fano 3-folds and two infinite families of Sasaki-Einstein 7-manifolds with known metrics.

10:30am **Workshop: Coffee Break - SCGP Cafe**

**Title:** Coffee Break

11:00am **Workshop: Jirui Guo - SCGP 102**



**Speaker:** Jirui Guo

**Title:** Derived equivalence and homological projective duality in GLSM

**Abstract:** Brane transport provides an effectual way to realize functors between the categories of B-branes of different phases in GLSM. When carefully designed, these functors induce derived equivalence between Calabi-Yau manifolds. In some cases, brane transport can also be used to extract the homological projective dual of certain projective embeddings. In this talk, I will describe the GLSMs realizing derived equivalence between different geometries via brane transport, and how to construct the GLSMs where brane transport gives rise to the embedding of homological projective dual category into the derived category of universal hyperplane section. I will also talk about how to use this construction to translate the hybrid model description of the homological projective dual into a geometric description in terms of the derived categories of noncommutative resolutions.

12:00pm **Workshop: Lunch - SCGP Cafe**

**Title:** Lunch

1:15pm **Workshop: Nana Cabo Bizet - SCGP 102**

**Speaker:** Nana Cabo Bizet

**Title:** Non-Abelian T-dualities in gauged linear sigma models

**Abstract:** We explore non-Abelian T-dualities in Gauged Linear Sigma Models in two dimensions with (2,2) and (2,0) supersymmetry and U(1) gauge group. These constitute generalizations of the Abelian T-duality that give rise to mirror symmetric models. We have constructed the duality by gauging global symmetries of a given GLSM and adding Lagrange multiplier fields, interpolating between dual models. In the (2,2) case we discuss the duality for the GLSM with  $SU(2) \times SU(2)$  global symmetry and vacuum given by the resolved conifold. We also present the non-Abelian dualization of the (2,0) models. We expect these dualities to give rise to new geometric relations and physical equivalences.

2:15pm **Workshop: Break - SCGP 102**

**Title:** Break

2:30pm **Workshop: Mikhail Litvinov - SCGP 102**

**Speaker:** Mikhail Litvinov

**Title:** Boundary Conditions and Chiral Algebra Extensions in 3D  $N=2$  Supersymmetric QFTs on an Interval

**Abstract:** This talk will discuss boundary conditions in three-dimensional  $N=2$  supersymmetric QFTs that preserve  $(0,2)$  supersymmetry and support boundary vertex algebras. When a theory is put on an interval with  $N=(0,2)$  boundary conditions, the total chiral algebra is obtained by extending the tensor product of the boundary chiral algebras by their bimodules. As an example, we will consider a chiral algebra in the reduction of 3D  $N=2$  supersymmetric gauge theories on an interval with  $N=(0,2)$  Dirichlet boundary conditions on both ends, which is related to chiral differential operators on the group. A full non-perturbative result is found in the abelian case, in which the chiral algebra is given by the rank two Narain lattice VOA.

3:30pm **Workshop: Tea time - SCGP Cafe**

**Title:** Tea time

4:00pm **Workshop: Konstantin Aleshkin - SCGP 102**

**Speaker:** Konstantin Aleshkin

**Title:** Higgs-Coulomb correspondence and wall-crossing in abelian GLSM

**Abstract:** I will explain two integral representations for abelian GLSM central charges: Hori-Romo hemisphere partition functions (Higgs-Coulomb correspondence) and mirror integrals. Then I plan to discuss implications of these representations and possible generalizations for K-theoretic invariants. The talk is based on joint works with Melissa Liu.

**Friday, May 26th**

9:00am **Workshop: Breakfast - SCGP Cafe**

**Title:** Breakfast

9:30am **Workshop: Mauricio Romo - SCGP 102**

**Speaker:** Mauricio Romo

**Title:** Hybrid models as mirrors of singular double covers

**Abstract:** I will present a construction of mirrors of singular Calabi-Yau double covers via noncommutative resolutions realized by GLSMs with hybrid phases. I will focus on the correspondence between A and B-periods and present some conjectures about their derived categories. This is based on joint work with Bong Lian and Tsung-Ju Lee.

10:30am **Workshop: Coffee Break - SCGP Cafe**

**Title:** Coffee Break

11:00am **Workshop: Thorsten Schimannek - SCGP 102**

**Speaker:** Thorsten Schimannek

**Title:** Counting curves on non-Kaehler Calabi-Yau 3-folds with hybrid GLSM

**Abstract:** In general, a Kaehler Calabi-Yau threefold with nodal singularities does not admit a Kaehler small resolution. This happens in particular if the exceptional curves are torsion in homology. However, the presence of torsion also leads to the possibility of turning on a flat, topologically non-trivial B-field that stabilizes the singularities. Using conifold transitions, we will describe a large family of examples for this phenomenon and explain how the resulting backgrounds can be studied using hybrid phases of gauged linear sigma models. This leads us to find some old and many new GLSM. Using the sphere partition function, we can then extract periods of the mirror Calabi-Yaus, which allows us to study the topological string partition functions. We argue that the latter encode Gopakumar-Vafa invariants associated to BPS states with discrete charges and that the invariants capture the enumerative geometry of the non-Kaehler small resolutions.

12:00pm **Workshop: Lunch - SCGP Cafe**

**Title:** Lunch

3:30pm **Workshop: Tea time - SCGP Cafe**

**Title:** Tea time